The opinion in support of the decision being entered today was not written for publication and is not binding precedent of the Board.

Paper No. 39

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte OSAMU SANO

Appeal No. 2004-1377
Application No. 09/582,870

HEARD: November 18, 2004

Before FRANKFORT, MCQUADE, and NASE, Administrative Patent Judges.

MCQUADE, Administrative Patent Judge.

DECISION ON APPEAL

Osamu Sano appeals from the final rejection (Paper No. 27) of claims 29, 30, 34 through 39 and 74 through 84. Claims 31 through 33, 41 through 43 and 56 through 58, the only other claims pending in the application, stand withdrawn from consideration.

THE INVENTION

The invention relates to a rotary-type hydraulic control valve for use in a power steering system. Representative claim 29 reads as follows:

> 29. A hydraulic control valve comprising:
> a valve body, including a plurality of valve body lands; and
> a valve spool, fitted into said valve body so as to be changeable in relative angle, said valve spool including a plurality of valve spool lands;
> wherein only one of said valve body and said valve spool includes pairs of chamfers which are so formed that each of ones of the valve body lands and the valve spool lands has only one chamfer.

THE PRIOR ART

The prior art items relied on by the examiner to support the final rejection are:

Kobayashi et al. (Kobayashi)	5,645,107	Jul. 08, 1997
Toyota Motor Corp. Japanese Patent Document (Yuuichi)[1]	8-104246	Apr. 23, 1996

The conventional hydraulic control valves and power steering systems discussed and shown, respectively, in the background

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[1] The appellant made the Yuuichi reference of record, without an English language translation, in an information disclosure statement filed July 6, 2000 (Paper No. 4). A translation, prepared for the USPTO subsequent to the appeal presumably at the behest of the examiner, is appended hereto. The record does not indicate that a copy was ever mailed to the appellant, a circumstance confirmed by counsel at the oral hearing.

section of the appellant's specification and in Figures 1 through 6 of the appellant's drawings (the admitted prior art).

THE REJECTION

Claims 29, 30 and 34 through 38 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Yuuichi in view of Kobayashi.

Claims 39 and 74 through 84 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Yuuichi in view of Kobayashi and the admitted prior art.

Attention is directed to the main and reply briefs (Paper Nos. 30 and 32) and the answer (Paper No. 31) for the respective positions of the appellant and the examiner regarding the merits of these rejections.

DISCUSSION

I. The 35 U.S.C. § 103(a) rejection of claims 29, 30 and 34 through 38 as being unpatentable over Yuuichi in view of Kobayashi

Yuuichi, the examiner's primary reference, discloses several embodiments of a hydraulic control valve used in power steering systems. For purposes of the appealed rejections, the examiner focuses on the embodiment illustrated in Figure 8. According to the examiner (see pages 3 and 4 in the answer), the valve shown in this drawing figure responds to all of the limitations in

independent claim 29 except for the one requiring that only one of the valve body and the valve spool includes pairs of chamfers. In this regard, the examiner observes that Figure 8 shows both the valve body 33 and the valve spool 31 as including pairs of chamfers. To overcome this failing in Yuuichi, the examiner turns to Kobayashi.

Kobayashi also discloses several embodiments of a hydraulic control valve used in power steering systems. The examiner notes that the embodiment illustrated in Figures 4A and 4B has chamfers only on the spool and submits that "[i]t would have been obvious to modify Yuuichi, by eliminating the chamfers on the valve body for ease of manufacture since Kobayashi discloses that the chamfers are only necessary on the sections of the spool posts that are adjacent the pump supply to reduce noise" (answer, page 4).

Kobayashi's extensive discussion of the use of chamfers in the type of hydraulic control valve at issue indicates that it is a rather complex subject having a significant, and somewhat unpredictable, effect on the operation of the valve. While the valve shown in Kobayashi's Figures 4A and 4B does have pairs of chamfers only on its spool component, such chamfers exist in pairs on respective lands on the spool. This latter feature is

inconsistent with the recitation in claim 29 that the component (valve body or spool) having the chamfers has only one chamfer on each one of its lands, as well as with the chamfer pattern shown in Yuuichi's Figure 8. Given the complexity of the subject matter at hand, it is evident that the only suggestion for the examiner's selective combination of the valves respectively shown in Yuuichi's Figure 8 and Kobayashi's Figures 4A and 4B stems from hindsight knowledge derived from the appellant's disclosure.

Accordingly, we shall not sustain the standing 35 U.S.C. § 103(a) rejection of claim 29, and dependent claims 30 and 34 through 38, as being unpatentable over Yuuichi in view of Kobayashi.

II. The 35 U.S.C. § 103(a) rejection of claims 39 and 74 through 84 as being unpatentable over Yuuichi in view of Kobayashi and the admitted prior art

Independent claim 39 contains limitations identical to those discussed above in connection with claim 29. Suffice to say that the examiner's application of the admitted prior art to support the rejection of claim 39 does not cure the above noted deficiencies of Yuuichi and Kobayashi with respect to these limitations.

Hence, we shall not sustain the standing 35 U.S.C. § 103(a) rejection of claim 39, and dependent claims 74 through 84, as

being unpatentable over Yuuichi in view of Kobayashi and the admitted prior art.

III. Remand to the examiner

This application is remanded to the examiner to reconsider the patentability of the appealed claims in light of the English language translation of the Yuuichi reference appended hereto.[2]

In describing the valve embodiment shown in Figure 8, the translation states that "chamfering portions (54) are formed only on the corner portions of the land portions positioned on the two sides of each slot portion where feeding path (42) connected to hydraulic generating source (13) is opened" (translation, page 12, paragraph [0035]), and that

> the chamfering portion formed on the land portion is set only on the side of the rotary valve member, and it is not formed on the sleeve valve member. Consequently, it becomes easier to manufacture the various valve members. Also, when the chamfering portion is formed on the side of the sleeve valve member, it is hard to form the chamfering start point at high precision. In this application example, as chamfering portion is formed only on the side of the rotary valve member, it is possible to form a control valve at high precision and having uniform characteristics [translation, page 13, paragraph [0038]].

[2] See n.1, supra.

These teachings belie the showing in Figure 8 of chamfers (unidentified by reference numerals) on valve body lands 38_2 and 38_8, or in the alternative describe a slightly different embodiment than that shown in Figure 8. In either case, such disclosure seems to be anticipatory with respect to the subject matter recited in representative claim 29. Furthermore, the description in the translation of the embodiment shown in Figure 9 also appears to be anticipatory with respect to the subject matter recited in claim 29.

On remand, the examiner is directed to (1) review the Yuuichi translation in full, giving particular attention to those portions thereof relating to Figures 8 and 9, (2) determine whether the disclosure therein, considered alone or in conjunction with other prior art references, justifies a prior art rejection of any of the appealed claims, and (3) enter such rejections if such are deemed to be warranted.

SUMMARY

The decision of the examiner to reject claims 29, 30, 34 through 39 and 74 through 84 is reversed, and the application is remanded to the examiner for further consideration.

Appeal No. 2004-1377
Application No. 09/582,870

REVERSED AND REMANDED

CHARLES E. FRANKFORT)
Administrative Patent Judge)
)
) BOARD OF PATENT
)
JOHN P. MCQUADE) APPEALS AND
Administrative Patent Judge)
) INTERFERENCES
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)
)
JEFFREY V. NASE)
Administrative Patent Judge)

JPM/kis

Appeal No. 2004-1377
Application No. 09/582,870

BIRCH, STEWART, KOLASCH & BIRCH
P. O. BOX 747
FALLS CHURCH, VA 22040-0747

PTO 04-192

Japanese Kokai Patent Application
No. Hei 8[1996]-104246

POWER STEERING DEVICE

Yuichi Kou and Kenichi Ichinose

UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. OCTOBER 2003
TRANSLATED BY THE RALPH MCELROY TRANSLATION COMPANY

JAPANESE PATENT OFFICE
PATENT JOURNAL (A)
KOKAI PATENT APPLICATION NO. HEI 8[1996]-104246

Int. Cl.[6]:	B 62 D 5/083
Filing No.:	Hei 6[1994]-241417
Filing Date:	October 5, 1994
Publication Date:	April 23, 1996
No. of Claims:	3 (Total of 9 pages; OL)
Examination Request:	Not filed

POWER STEERING DEVICE

[Doryoku kajitori sochi]

Inventors:	Yuichi Kou and Kenichi Ichinose
Applicant:	Toyota Motor Corp.

[There are no amendments to this patent.]

Claims /2*

1. A type of power steering device characterized by the following facts:

the power steering device has a power assisting mechanism and a control valve that controls the assisting force in the manipulating direction of steering corresponding to the relative actuating angle between an input shaft connected to steering and an output shaft connected to the steering mechanism;

in this power steering device, said control valve has an input member that is connected to the input shaft and has slot portions and land portions formed alternately on the outer periphery, and an output member that is connected to the output shaft and has slot portions and land portions formed alternately and facing said input member; a chamfering portion is formed on the corner portion of each of the land portions positioned on the two sides of said slot portion, which

* [Numbers in the margin indicate pagination in the foreign text.]

is opened to the feed path connected to a hydraulic generating source; and a chamfering portion is formed on the corner portion of each of the two sides of the land set facing said slot portion having the exhausting path connected to a reservoir tank opened to it.

2. A type of power steering device characterized by the following facts:

the power steering device has a power assisting mechanism and a control valve that controls the assisting force in the manipulating direction of steering corresponding to the relative actuating angle between an input shaft connected to steering and an output shaft connected to the steering mechanism;

in this power steering device, said control valve has an input member that is connected to the input shaft and has slot portions and land portions formed alternately on the outer periphery, and an output member that is connected to the output shaft and has slot portions and land portions formed alternately and facing said input member; a chamfering portion is formed on the corner portion of each of the land portions positioned on the two sides of said slot portion, which is opened to the feed path connected to a hydraulic generating source; and a right angle portion is formed on the corner portion of each of the corner portions on the two sides of said slot portion having the exhausting path connected to a reservoir tank opened to it and the land portion set facing it.

3. A type of power steering device characterized by the following facts:

the power steering device has a power assisting mechanism and a control valve that controls the assisting force in the manipulating direction of steering corresponding to the relative actuating angle between an input shaft connected to steering and an output shaft connected to the steering mechanism;

in this power steering device, said control valve has an input member that is connected to the input shaft and has slot portions and land portions formed alternately on the outer periphery, and an output member that is connected to the output shaft and has slot portions and land portions formed alternately and facing said input member; a chamfering portion is formed on the corner portion of each of the land portions positioned on the two sides of said slot portion, which is opened to the feed path connected to a hydraulic generating source; and a step portion is formed on the corner portion of each of the land portions positioned on the two sides of said slot portion having the exhausting path connected to a reservoir tank opened to it.

Detailed explanation of the invention

[0001]

Industrial application field

This invention pertains to a type of power steering device. Especially, this invention pertains to a type of power steering device that can assist the steering operation of the driver with a steering force applied on the steering wheel.

[0002]

Prior art

In the prior art, in order to improve the steering feeling of the vehicle, various types of power steering devices have been developed. In the conventional power steering device, a hydraulic pump driven by the engine of the vehicle is taken as the hydraulic generating source, and the hydraulic pressure is used as an assisting steering force when the steering wheel is steered.

[0003]

In the aforementioned power steering device, a control valve for controlling the steering force to the steering wheel corresponding to the steering operation of the driver and a steering force assisting mechanism that assists the steering force with the hydraulic pressure fed from the control valve are set. The control valve has an input shaft that rotates integrally with the steering shaft of the steering wheel and an output shaft that transfers the driving force to the steering wheel through a torsion bar.

[0004]

As the steering wheel is steered, the torsion bar is twisted, and a relative displacement is generated between the input shaft and the output shaft. In this case, depending on the torsional direction of the torsion bar, the throttle formed in the hydraulic path between the input shaft and output shaft is switched, and the hydraulic pressure to the steering force assisting mechanism is fed so that the steering wheel is energized to the left direction or right direction. For example, the device described in Japanese Kokai Patent Application No. Hei 3[1991]-14769 is used as the conventional power steering device. As shown in Figure 10, the power steering device described in this patent has land portions (1a) and slot portions (1b) formed alternately on sleeve valve member (1) on the output side, and land portions (2a) and slot portions (2b) are formed alternately on rotor valve member (2) on the input side facing sleeve valve member (1).

[0005]

Due to torsion of said tubular member, the portion between the corner portion of land portion (1a) of sleeve valve member (1) and the corner portion of land portion (2a) of rotor valve member (2) becomes narrower, forming throttle (8). Said throttle (8) restricts the flow direction of the actuating fluid. Together with this, the actuating fluid fed from hydraulic pump (3) flows through the gap in the wide portion between land portion (1a) and land portion (2a), and it is fed into one chamber of driving cylinder (4). Consequently, the driving force of cylinder (4) for driving assists steering of the steering wheel to steer the direction. Also, the actuating fluid exhausted from the other chamber of cylinder (4) for driving is recycled to reservoir tank (7).

[0006]

Problems to be solved by the invention

However, for the power steering device in the aforementioned patent, chamfering portion (5) is formed for the corner portion of each land portion (2a) of rotor valve member (2) so as to smoothen the pressure variation with respect to the steering angle. As shown in the enlarged view in Figure 11, the actuating fluid passes through gap S of throttle (8) formed between chamfering portion (5) and land portion (1a) of sleeve valve member (1), and it flows to the reservoir tank.

[0007]

When said gap S functions as a throttle, inlet Sa for flow-in of the actuating fluid becomes smaller, and outlet Sb for flow-out of the actuating fluid becomes larger. Consequently, the actuating fluid is significantly reduced in velocity as it flows through gap S. Consequently, negative pressure region (6) (indicated by broken line in Figure 11) is generated near the inlet. Consequently, in the aforementioned conventional power steering device, as actuating fluid flows through gap S, cavitation takes place in negative pressure region (6). As a result, noise is generated. This is undesirable.

[0008]

The purpose of this invention is to solve the aforementioned problems of the prior art by providing a when the hydraulic fluid fed from the hydraulic generating source flows to the reservoir tank through the throttle portion between the land portion on the input side and the land portion on the output side, the area of the flow path of the throttle portion becomes smaller, and it is possible to prevent generation of noise due to cavitation. /3

[0009]

Means to solve the problem

The invention described in Claim 1 provides a type of power steering device characterized by the following facts: the power steering device has a power assisting mechanism and a control valve that controls the assisting force in the manipulating direction of steering corresponding to the relative actuating angle between an input shaft connected to steering and an output shaft connected to the steering mechanism; in this power steering device, said control valve has an input member that is connected to the input shaft and has slot portions and land portions formed alternately on the outer periphery, and an output member that is connected to the output shaft and has slot portions and land portions formed alternately and facing said input member; a chamfering portion is formed on the corner portion of each of the land portions positioned on the two sides of said slot portion, which is opened to the feed path connected to a hydraulic generating source; and a chamfering portion is formed on the corner portion of each of the two sides of the land set facing said slot portion having the exhausting path connected to a reservoir tank opened to it.

[0010]

The invention described in Claim 2 provides a type of power steering device characterized by the following facts: the power steering device has a power assisting mechanism and a control valve that controls the assisting force in the manipulating direction of steering corresponding to the relative actuating angle between an input shaft connected to steering and an output shaft connected to the steering mechanism; in this power steering device, said control valve has an input member that is connected to the input shaft and has slot portions and land portions formed alternately on the outer periphery, and an output member that is connected to the output shaft and has slot portions and land portions formed alternately and facing said input member; a chamfering portion is formed on the corner portion of each of the land portions positioned on the two sides of said slot portion, which is opened to the feed path connected to a hydraulic generating source; and a right angle portion is formed on the corner portion of each of the corner portions on the two sides of said slot portion having the exhausting path connected to a reservoir tank opened to it and the land portion set facing it.

[0011]

The invention described in Claim 3 provides a type of power steering device characterized by the following facts: the power steering device has a power assisting mechanism and a control valve that controls the assisting force in the manipulating direction of steering corresponding to the relative actuating angle between an input shaft connected to steering and an

output shaft connected to the steering mechanism; in this power steering device, said control valve has an input member that is connected to the input shaft and has slot portions and land portions formed alternately on the outer periphery, and an output member that is connected to the output shaft and has slot portions and land portions formed alternately and facing said input member; a chamfering portion is formed on the corner portion of each of the land portions positioned on the two sides of said slot portion, which is opened to the feed path connected to a hydraulic generating source; and a step portion is formed on the corner portion of each of the land portions positioned on the two sides of said slot portion having the exhausting path connected to a reservoir tank opened to it.

[0012]

Operation

For the constitution of Claim 1, as the hydraulic fluid fed from a hydraulic generating source flows through the throttle portion (chamfering portion) into a reservoir tank, the area of the flow path of the throttle portion gradually becomes smaller. Consequently, no negative pressure is generated in the throttle portion, and it is possible to prevent generation of noise due to cavitation.

[0013]

In the constitution of Claim 2, while the area of the flow path gradually becomes smaller in one throttle portion, for the other throttle portion, the right angle portions approach each other. Consequently, almost the entire flow rate excluding the flow rate to the cylinder flows in the flow path with the area of the flow path gradually becoming smaller, and it is possible to prevent generation of cavitation and noise due to generation of a negative pressure. In the other throttle portion, there is no change in the area of the flow path. Consequently, as the actuating fluid flows through the throttle portion, there is no change in the flow velocity, and generation of negative pressure can be prevented. For the invention described in Claim 3, by adopting a constitution in which step portion is formed in the corner portion of each of the land portions positioned on the two sides of the slot portion where the exhausting path connected to the reservoir tank is opened, the fluid escapes even in the step portion, the load on the chamfering portion generated due to excessive concentration of the flow in the chamfering portion where the flow path gradually becomes smaller can be alleviated, and it is possible to effectively prevent generation of noise due to cavitation.

[0014]

Application examples

Figures 1-5 illustrate an application example of the power steering device of the invention of this patent application. In these figures, the power steering device is mainly composed of control valve (11), hydraulic cylinder (12) that functions as a steering force assisting mechanism, hydraulic pump (13) as a hydraulic source, and reservoir tank (14) for recycling the actuating fluid.

[0015]

Control valve (11) has gear housing (20) and valve housing (21) integrated to each other. Output shaft (22) are supported in a free rotatable way by bearings (23a), (23b) set in gear housing (20) and valve housing (21). Also, pinion (22a) of output shaft (22) is engaged to rack (24a) of rack shaft (24) supported in a free reciprocal movable way in the direction cross output shaft (22).

[0016]

Rack shaft (24) has piston (25) of hydraulic cylinder (12), and, at the same time, it is linked through a link mechanism (not shown in the figure) to the steering wheel. Input shaft (27) supported in a free rotatable way by bearings (26a), (26b) is inserted in gear housing (20) and valve housing (21). This input shaft (27) is supported coaxial to output shaft (22), while one end is connected through a steering shaft to the steering wheel (both not shown in the figure).

[0017]

Also, output shaft (22) and input shaft (27) are connected to each other in a relative rotatable way via torsion bar (28) inserted in hollow portion (27a) of input shaft (27). Consequently, output shaft (22) and input shaft (27) make relative rotation corresponding to the angle of torsion of torsion bar (28). Rotary servo valve portion (30) (hereinafter referred to as "valve portion (30)") is set between said output shaft (22) and input shaft (27). Said valve portion (30) is composed of rotary valve member (input member) (31) set on input shaft (27), and sleeve valve member (output member) (33), which is fit in a free rotatable way on the outer peripheral surface of rotary valve member (31) and inner periphery (21a) of valve housing (21), and which is connected to output shaft (22) by means of joining pin (32).

[0018]

Also, valve portion (30) has feeding port (34), exhausting port (35) and a pair of feeding/exhausting ports (36), (37), and it is a 4-port throttle switching valve. Said feed port (34)

/5

is connected through feeding pipeline (46a) to hydraulic pump (13); hydraulic pump (13) is connected through suction pipeline (46b) to reservoir tank (14); and exhausting port (35) is connected through exhausting pipeline (47) to reservoir tank (14).

[0019]

As shown in Figure 4, eight land portions (38_1)-(38_8) and eight slot portions (39_1)-(39_8) are formed alternately on the inner periphery of sleeve valve member (33). As shown in Figure 5, on the outer periphery of rotary valve member (31), eight land portions (40_1)-(40_8) and eight slot portions (41_1)-(41_8) are formed alternately. Consequently, land portions (38_1)-(38_8) and slot portions (39_1)-(39_8) of sleeve valve member (33) are set facing slot portions (41_1)-(41_8) and land portions (40_1)-(40_8) of rotary valve member (31), respectively, and passage can be made through the small gap between the end portions of land portions (38_1)-(38_8) and the end portions of land portions (40_1)-(40_8).

[0020]

Feeding path (42) is opened to every other land portion (38_1), (38_3), (38_5), (38_7) among land portions (38_1)-(38_8) of sleeve valve member (33). Each feeding path (42) is connected to feeding port (34) that feeds the actuating fluid fed under pressure from hydraulic pump (13). Also, exhausting path (43) is opened to every other slot portion (41_2), (41_4), (41_6), (41_8) among slot portions (41_1)-(41_8) of rotary valve member (31). Each exhausting path (43) is connected to path (44) formed between input shaft (27) and torsion bar (28). In addition, path (44) is connected to exhausting port (35) through exhausting hole (45) formed through input shaft (27).

[0021]

Distributing holes (48), (49) (represented by broken lines in Figure 4) are opened alternately in slot portions (39_1)-(39_8) of sleeve valve member (33) alternately, one hole in each slot portion, and distributing holes (48), (49) are connected to said feeding/exhausting ports (36), (37). Also, feeding/exhausting ports (36), (37) are connected through pipelines (51), (52) to left/right cylinder chambers (12a), (12b) of hydraulic cylinder (12), respectively.

[0022]

As shown in the enlarged view in Figure 4, for land portions (38_1)-(38_8) of said sleeve valve member (33), chamfering portion (53) is formed on each of the two side corner portions of each of land portions (38_2), (38_4), (38_6), (38_8) of sleeve valve member (33) where feeding path (42) for feeding the ejecting pressure ejected from hydraulic pump (13) is not opened. Also, as shown in the enlarged view in Figure 5, for land portions (40_1)-(40_8) of rotary valve member

(31), chamfering portion (54) is formed only in the corner portions of the land portions positioned on the two sides of slot portions (41_1), (41_3), (41_5), (41_7) where exhausting path (43) is not opened.

[0023]

Consequently, in this application example, chamfering portion is not formed on all of the corner portions of land portions (40_1)-(40_8) or land portions (38_1)-(38_8). Instead, chamfering portion (54) is formed on each of the corner portions on the two sides of each of slot portions (41_1), (41_3), (41_5), (41_7) where feeding path (42) for feeding the actuating fluid ejected from hydraulic pump (13) is opened, and chamfering portion (53) is formed on each of the corner portions on the two sides of each of slot portions (38_2), (38_4), (38_6), (38_8) set facing slot portions (41_2), (41_4), (41_6), (41_8) where exhausting path (43) connected to the reservoir tank is opened.

[0024]

When a steering torque is applied on input shaft (27) as said steering wheel is manipulated, torsion bar (28) is twisted, and, as shown in Figure 3, rotary valve member (31) makes displacement in direction A. Also, as shown in Figure 3, explanation is made with respect to an enlarged view of the periphery of one feeding path (42). The same constitution is adopted for the periphery of the other feeding paths. Consequently, they are not shown in the figures. As a result, the corner portion of land portion (38_1) of sleeve valve member (33) and chamfering portion (54) of the corner portion of land portion (40_8) of rotary valve member (31) approach each other to form first throttle (55). At the same time, chamfering portion (53) of the corner portion of land portion (38_2) of sleeve valve member (33) and the corner portion of land portion (40_1) of rotary valve member (31) also approach each other to form second throttle (56).

[0025]

As shown in the enlarged view in Figure 6(A), the actuating fluid flows as indicated by the arrow in first throttle (55). In first throttle (55), gap S formed between chamfering portion (54) of land portion (40_8) and the corner portion of land portion (38_1) for inlet Sa has an opening area larger than that for outlet Sb. Consequently, the actuating fluid passing through said first throttle (55) flows slowly from larger inlet Sa to smaller outlet Sb. There is no deceleration in the process of flowing from inlet Sa to outlet Sb. Consequently, no negative region is generated inside first throttle (55), and it is possible to prevent generation of cavitation and generation of noise.

[0026]

As shown in the enlarged view in Figure 6(B), the actuating fluid flows as indicated by the arrow in second throttle (56). In second throttle (56), too, for gap S formed between chamfering portion (53) of land portion (38_2) and the corner portion of land portion (40_1), the opening area at inlet Sa is larger than that of outlet Sb. Consequently, just as in the aforementioned case of first throttle (55), the actuating fluid passing through second throttle (56) flows slowly from larger inlet Sa to outlet Sb having a smaller path area, and there is no deceleration in the process of flow from inlet Sa to outlet Sb. Consequently, no negative pressure region is generated inside second throttle (56), and it is possible to prevent generation of cavitation and thus generation of noise.

[0027]

As explained in the above, in the hydraulic path formed between the outer periphery of rotary valve member (31) and the inner periphery of sleeve valve member (33), first throttle (55) and second throttle (56) are formed by twisting torsion bar (28). Consequently, the actuating fluid ejected from feeding path (42) to the hydraulic path has its flow restricted by throttles (55), (56). It passes through distributing hole (48) that opens to slot portion (39_1) and is fed to right cylinder chamber (12b) of hydraulic cylinder (12) to provide an assisting steering force. /7

[0028]

Also, when torsion bar (28) is twisted in the direction opposite to said direction, the actuating fluid flows through distributing hole (49) that opens in slot portion (39_8) and is fed to left cylinder chamber (12a) of hydraulic cylinder (12). Figure 7 is a diagram illustrating the structure of a modification example of valve portion (30) in said application example. Basically, rotary valve member (31) and sleeve valve member (33) of valve portion (30) shown in Figure 7 have the same structure as that shown in said Figures 1-6, although there are changes in the positions of article holder feeding path (42), exhausting path (43), distributing holes (48) and (49), as well as the chamfering position of the land portions. Consequently, the same part numbers as those used in said Figure 3 are adopted here.

[0029]

As shown in the figure, feeding path (42) is opened to the bottom of every other slot portion (39_1), (39_3), (39_5), (39_7) among slot portions (39_1)-(39_8) of sleeve valve member (33). Also, exhausting path (43) is opened to every other land portions (40_2), (40_4), (40_6), (40_8) among slot portions (40_1)-(40_8) of rotary valve member (31). Distributing holes (48) and (49) are opened

alternately in land portions (38_1)-(38_8) of sleeve valve member (33), one distributing hole for each land portion.

[0030]

Chamfering portion (53) is formed on the corner portion of each of the land portions positioned on the two sides of each of slot portions (39_1), (39_3), (39_5), (39_7) where feeding path (42) is opened among slot portions (39_1)-(39_8) of said sleeve valve member (33). Also, chamfering portion (54) is formed on each of the corner portions on the two sides of land portions (40_2), (40_4), (40_6), (40_8) where exhausting path (43) is opened among land portions (40_1)-(40_8) of rotary valve member (31).

[0031]

Here, when the aforementioned steering wheel is manipulated, torsion bar (28) is twisted to make elastic deformation. Consequently, rotary valve member (31) makes displacement in direction A. As a result, the corner portion of land portion (38_1) of sleeve valve member (33) and chamfering portion (54) formed on the corner portion of land portion (40_8) of rotary valve member (31) approach each other to form first throttle (55). At the same time, the corner portion of land portion (40_1) of rotary valve member (31) and chamfering portion (54) formed on the corner portion (40) of rotary valve member (31) approach each other to form second throttle (56).

[0032]

As shown in said Figures 6(A), (B), in first throttle (55) and second throttle (56), the actuating fluid flows from larger inlet Sa to smaller outlet Sb, and there is no deceleration during the flow process from inlet Sa to outlet Sb. Consequently, no negative pressure region is generated inside first throttle (55) and second throttle (56), generation of cavitation can be prevented, and thus generation of noise can be prevented.

[0033]

In said Figure 7, explanation is made with respect to an enlarged view of the periphery of one feeding path (42). The other feeding path peripheries have the same constitution, and they are not shown in the figure. Figure 8 is a diagram illustrating the structure of the various valve members of the control valve in another application example of the power steering device in the invention of this patent application. The valve portion in this application example has basically the same constitution as that shown in Figure 3, although there are changes in the positions of the

chamfering portions formed on the corner portions of the various land portions. Consequently, the same part numbers as those in Figure 3 are adopted in Figure 8.

[0034]

As shown in this figure, feeding path (42) is formed in every other land portion (38_1), (38_3), (38_5), (38_7) among land portions (38_1)-(38_8) of sleeve valve member (33). Also, distributing holes (48), (49) are opened alternately in slot portions (39_1)-(39_8) of sleeve valve member (33), with one distributing hole for each slot portion. On the other hand, exhausting path (43) is opened on the bottom portion of every other slot portion (41_2), (41_4), (41_6), (41_8) among slot portions (41_1)-(41_8) of rotary valve member (31).

[0035]

Chamfering portion (54) is formed on the corner portion of each of the land portions positioned on the two sides of each of slot portions (41_1), (41_3), (41_5), (41_7) where feeding path (42) is opened among slot portions (41_1)-(41_8) of said rotary valve member (31). Consequently, in this application example, chamfering portions (54) are formed only on the corner portions of the land portions positioned on the two sides of each slot portion where feeding path (42) connected to hydraulic generating source (13) is opened, and the corner portions on the two sides of each of slot portions (41_2), (41_4), (41_6), (41_8) where exhausting path (43) connected to the reservoir tank and land portions (38_2), (38_4), (38_6), (38_8) set facing them. When the aforementioned steering wheel is manipulated, torsion bar (28) is twisted to make elastic deformation, so that rotary valve member (31) makes displacement in direction A.

[0036]

As a result, the corner portion of land portion (38_1) of sleeve valve member (33) and chamfering portion (54) formed on the corner portion of land portion (40_8) of rotary valve member (31) approach each other to form first throttle (55). At the same time, right angle portion (57) of the corner portion of land portion (40_1) of rotary valve member (31) and right angle portion (57) of the corner portion of land portion (38_2) of sleeve valve member (33) also approach each other to form second throttle (56).

[0037]

As a result, throttle portion (55) of slot portion (41_1) connected to hydraulic generating source (13) gradually becomes smaller. On the other hand, throttle portion (56) of slot portion (41_2) connected to reservoir tank (14) becomes a right angle, and the flow is restricted. Consequently, in this application example, almost the entire flow rate from hydraulic generating

source (13), excluding the flow rate flowing to cylinder (12) passes through the narrow chamfering portions, and there exists no wide flow. As a result, it is possible to prevent generation of noise due to cavitation.

[0038]

Also, according to this application example, the chamfering portion formed on the land portion is set only on the side of the rotary valve member, and it is not formed on the sleeve valve member. Consequently, it becomes easier to manufacture the various valve members. Also, when the chamfering portion is formed on the side of the sleeve valve member, it is hard to form the chamfering start point at high precision. In this application example, as chamfering portion is formed only on the side of the rotary valve member, it is possible to form a control valve at high precision and having uniform characteristics.

[0039]

Figure 9 is a diagram illustrating another application example of the invention of this patent application. In the application example shown in Figure 8 [sic; 9], step portion (58) is formed on the corner portion of each of the land portions positioned on the two sides of slot portions (41_2), (41_4), (41_6), (41_8) of rotary valve member (31) where exhausting path (43) connected to reservoir tank (14) is opened. /9

Consequently, in the valve portion of this application example, chamfering portion (54) is formed on the corner portion of each of the land portions positioned on the two sides of each of slot portions (41_1), (41_3), (41_5), (41_7) where feeding path (42) connected to hydraulic generating source (13) is opened, and step portion (58) is formed on the corner portion of each of the land portions positioned on the two sides of each of the slot portions where exhausting path (43) connected to reservoir tank (14) is opened.

[0040]

In this application example, as the steering wheel is manipulated, rotary valve member (31) makes displacement in direction A. As a result, the corner portion of land portion (38_1) of sleeve valve member (33) and chamfering portion (54) formed on land portion (40_8) of rotary valve member (31) approach each other to form throttle (55). At the same time, the corner portion of land portion (38_2) of sleeve valve member (33) and step portion (58) of land portion (40_1) of rotary valve member (31) approach each other to form second throttle (56).

[0041]

Here, in first throttle (55), the area of flow channel gradually becomes smaller to form a flow channel. Just as in the aforementioned application example, generation of cavitation can be prevented, and it is possible to prevent generation of noise due to cavitation. In second throttle (56), as step portion (58) is formed on the corner portion of land portion (40_1) of rotary valve member (31), gap S' for flow of the hydraulic fluid is formed.

[0042]

In the application example shown in Figure 8, in throttle (56), the hydraulic fluid is almost entirely stopped. Consequently, the flow may be excessively concentrated in throttle (55) where the area of the flow channel is small. When the system has a high ejecting flow rate of pump (13) as the hydraulic generating source, even when the throttle has a small area of the flow channel, cavitation may still take place. In this application example, by having a prescribed amount of the actuating fluid escape through throttle (56), the load on throttle (55) is reduced so that cavitation can be prevented.

[0043]

In the application example shown in Figures 8 and 9, feeding path (42) connected to pressure generating source (13) is set on land portions (38_1), (38_3), (38_5), (38_7) of sleeve valve member (33). However, just as in the application example shown in Figure 7, it is also possible to set the opening portion of feeding path (42) in slot portions (39_1), (39_3), (39_5), (39_7) of sleeve valve member (33). In addition, in the aforementioned application examples, a rotary type control valve is explained as an example. However, this invention is not limited to this type of valve. One may also adopt this invention on a spool type control valve that slides along a spool.

[0044]

Effects of the invention

For the constitution of Claim 1, as the hydraulic fluid fed from a hydraulic generating source flows through the throttle portion into a reservoir tank, the area of the flow path of the throttle portion gradually becomes smaller. Consequently, no negative pressure is generated in the throttle portion, and it is possible to prevent generation of noise due to cavitation.

[0045]

In the constitution of Claim 2, the area of the flow path in the slot portion and land portion connected to the hydraulic generating source of the control valve gradually becomes smaller, so that it is possible to prevent generation of noise due to cavitation just as in said

Claim 1. Also, as the throttle portion of the slot portion and land portion connected to the reservoir is formed as the right angle portion, it is possible to prevent cavitation and noise due to generation of a negative pressure. Also, there is no need to form a chamfering portion on the output member when the valve members are manufactured, so that manufacturing becomes easier. Also, while steering angle versus hydraulic pressure (θ-P) characteristics, that is, characteristics of the control valve, can be adjusted by means of the chamfering portion, in this case, it is possible to perform this adjustment by simply adjusting the chamfering portion of the input member. As a result, the manufacturing cost can be reduced.

[0046]

For the invention described in Claim 3, by forming chamfering portion on the corner portions of the land portions positioned on the two sides of the slot portion connected to the hydraulic generating source and by forming a step portion on the corner portions of the land portions positioned on the two sides of the slot portion where the exhausting path connected to the reservoir tank is opened, the fluid can escape in the step portion in one throttle portion. As a result, the load on the throttle portion having its area of flow channel gradually becoming smaller can be reduced with respect to that in the case described in Claim 2, and it is possible to effectively prevent generation of noise due to cavitation. Also, as there is no need to form chamfering portions and step portions on the output member when the valve members are manufactured, the manufacturing operation becomes easier.

Brief description of the figures

Figure 1 is a longitudinal cross-sectional view illustrating the main portion in an application example of the power steering device of this invention.

Figure 2 is a longitudinal cross-sectional view illustrating the constitution of the control valve of the power steering device.

Figure 3 is an enlarged longitudinal cross-sectional view illustrating a portion of the hydraulic path and throttle formed between the sleeve valve member and the rotary valve member.

Figure 4 is an enlarged longitudinal cross-sectional view illustrating the sleeve valve member.

Figure 5 is an enlarged longitudinal cross-sectional view illustrating the rotary valve member.

Figure 6 is an enlarged longitudinal cross-sectional view illustrating the first throttle and the second throttle.

Figure 7 is an enlarged longitudinal cross-sectional view illustrating a portion of a modified application example of this invention.

Figure 8 is an enlarged longitudinal cross-sectional view illustrating a portion of the valve member of another application example of this invention.

Figure 9 is an enlarged longitudinal cross-sectional view illustrating a portion of the valve member in another application example of this invention.

Figure 10 is a longitudinal cross-sectional view illustrating the constitution of the prior art.

Figure 11 is a longitudinal cross-sectional view the shape of the throttle in the prior art.

Brief description of part numbers

11 Control valve
12 Hydraulic cylinder
13 Hydraulic pump
14 Reservoir tank
22 Output shaft
24 Rack shaft
25 Piston
27 Input shaft
28 Torsion bar
30 Rotary servo valve portion
31 Rotary valve member
33 Sleeve valve member
38_1-38_8 Land portion
39_1-39_8 Slot portion
40_1-40_8 Land portion
41_1-41_8 Slot portion
42 Feeding path
43 Exhausting path
46a Feeding pipeline
46b Suction pipeline
47 Exhausting pipeline
53, 54 Chamfering portion
57 Right angle portion
58 Step portion

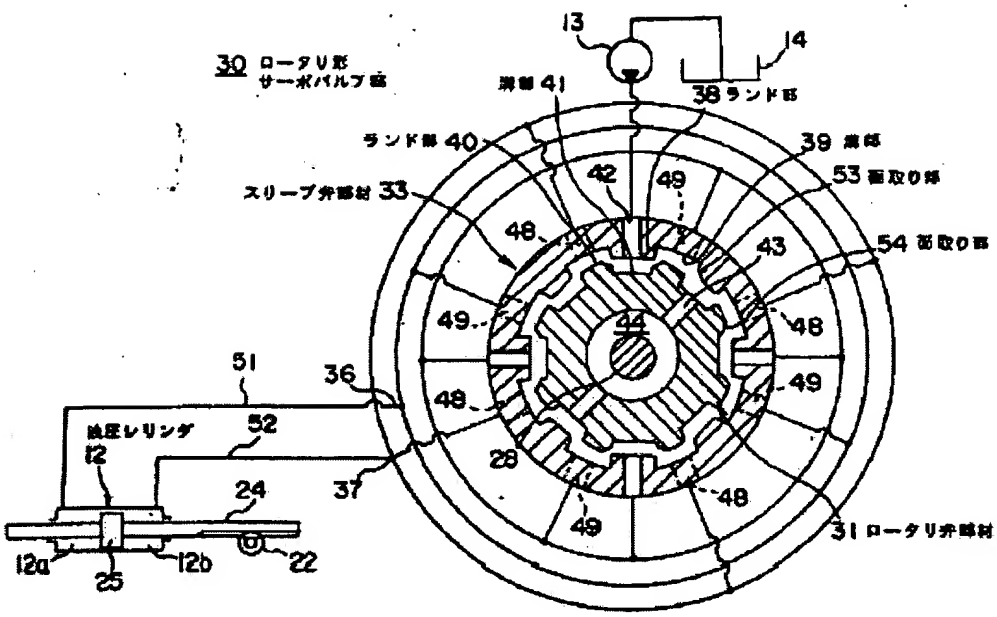

Figure 1

Key:
- 12 Hydraulic cylinder
- 30 Rotary servo valve portion
- 31 Rotary valve member
- 33 Sleeve valve member
- 38 Land portion
- 39 Slot portion
- 40 Land portion
- 41 Slot portion
- 53 Chamfering portion
- 54 Chamfering portion

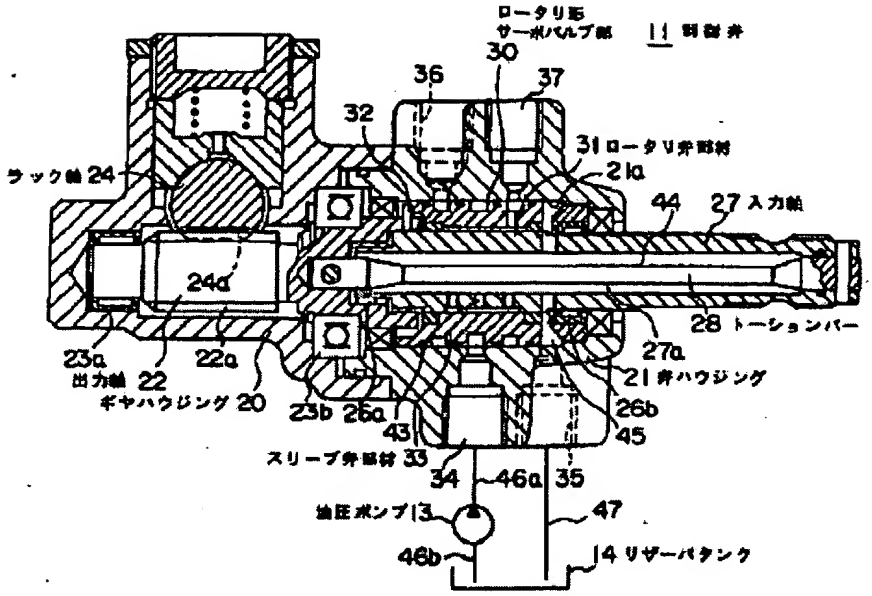

Figure 2

Key:
	11	Control valve
	13	Hydraulic pump
	14	Reservoir tank
	20	Gear housing
	21	Valve housing
	22	Output shaft
	24	Rack shaft
	27	Input shaft
	28	Torsion bar
	30	Rotary servo valve portion
	31	Rotary valve member
	33	Sleeve valve member

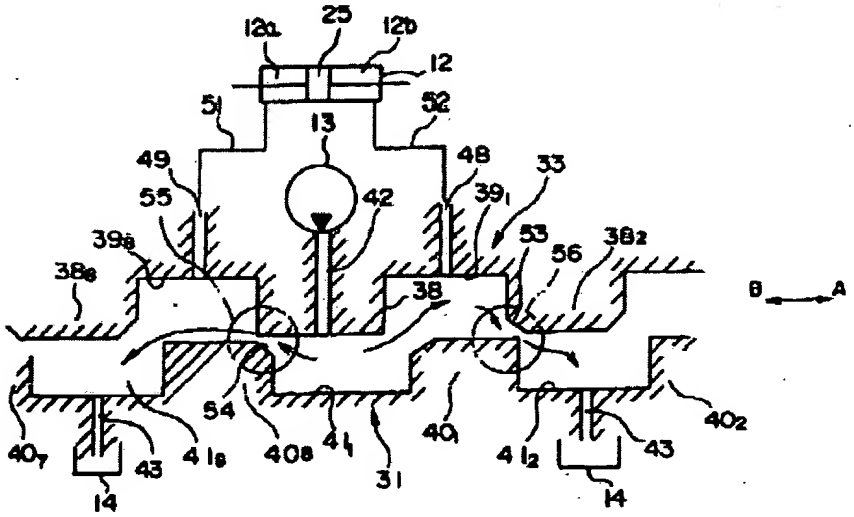

Figure 3

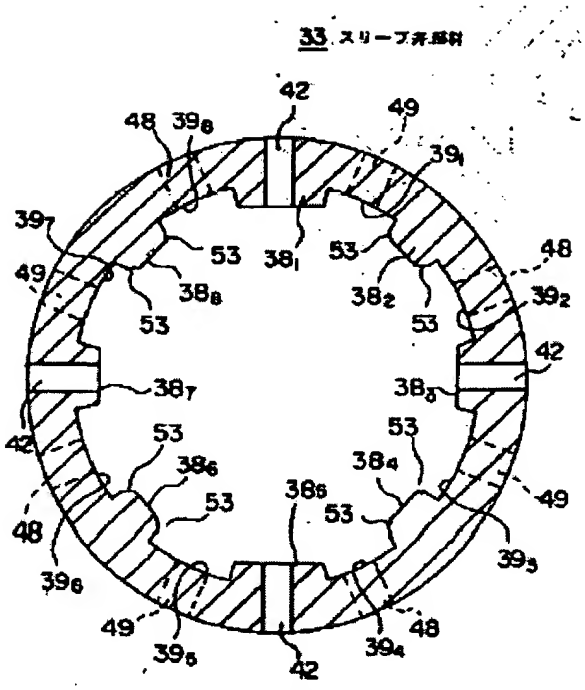

Figure 4

Key: 33 Sleeve valve member

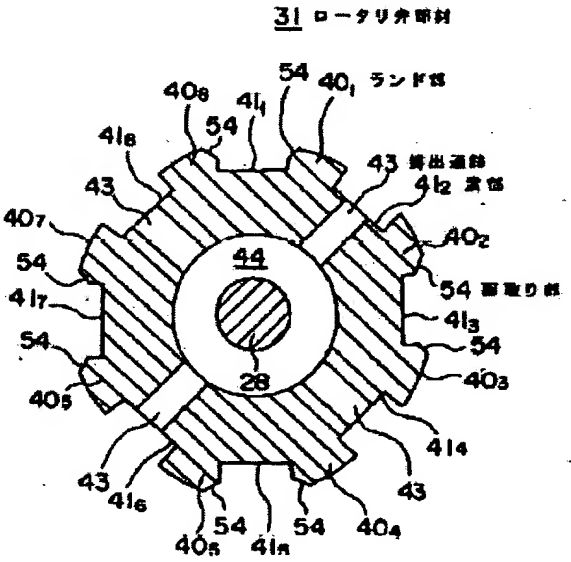

Figure 5

Key: 31 Rotary valve member
40_1 Land portion
41_2 Slot portion
43 Exhausting path
54 Chamfering portion

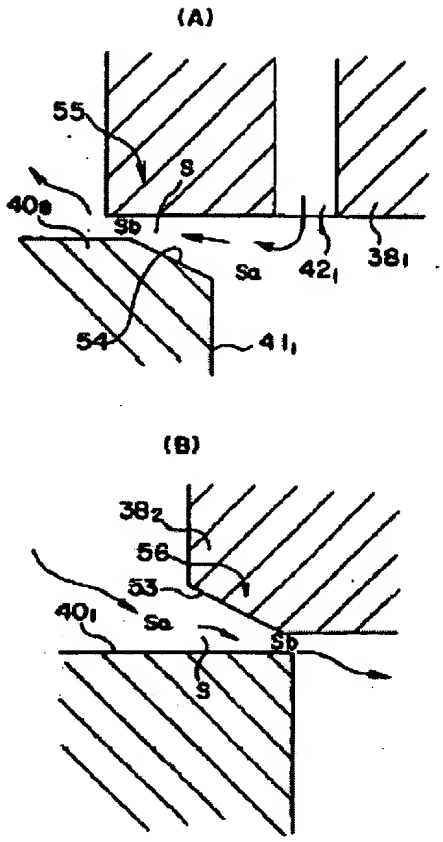

Figure 6

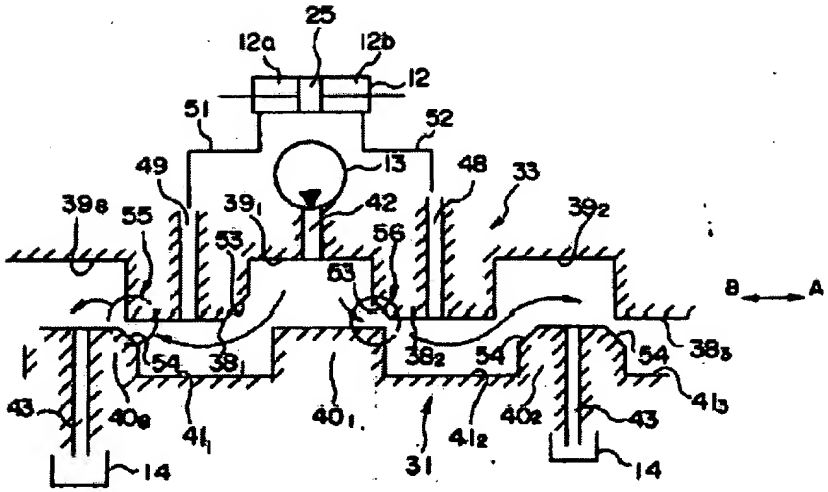

Figure 7

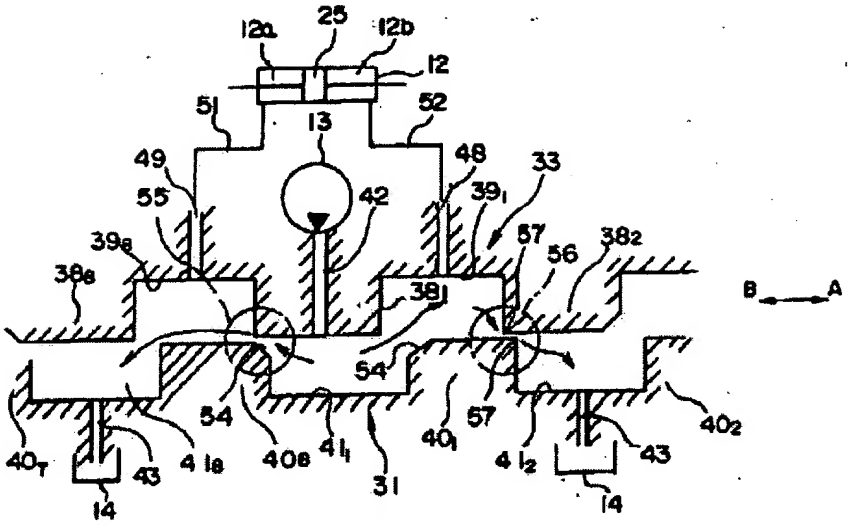

Figure 8

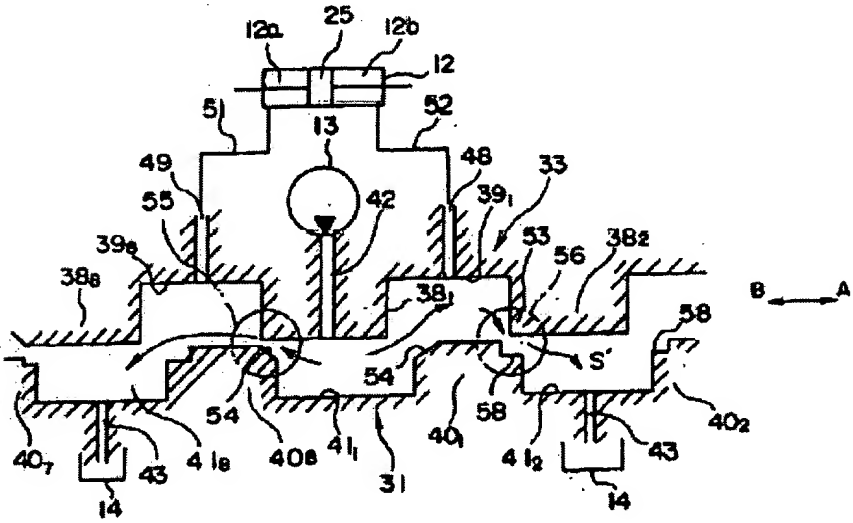

Figure 9

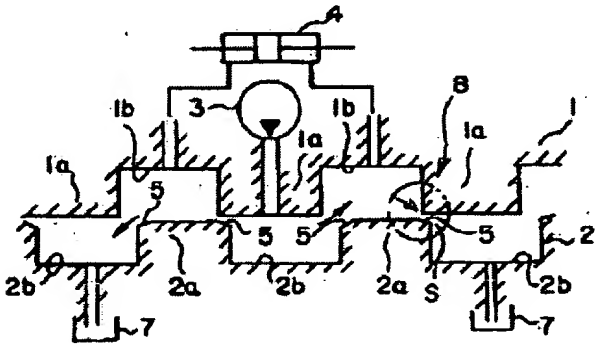

Figure 10

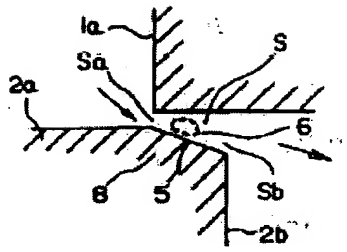

Figure 11